

YAQUINA BAY, LINCOLN CO., OR;
NORTH MARINA BREAKWATER; PRELIMINARY EVALUATION - FOUNDATION
CONDITION STUDY FOR MAJOR MAINTENANCE REPORT

Background The North Breakwater in Yaquina Bay North Marina is under study for a Sec. 107 major maintenance action to repair or replace the federally authorized breakwater structure. The Federal project includes the North Marina breakwater and shorewing, but the boat basin is not maintained by the Corps. Protection of the basin is provided by a breakwater erected on a shoal, and shoaling still occurs along both sides of the breakwater, including the reach adjacent to the north margin of the Federal channel. Although this shoal development does not materially affect the Federal channel, sediments from this location are of interest with respect to physical parameters because they are a potential source of shoal material in the channel and because under certain repair alternatives being considered, access to the breakwater would require dredging at the base of the structure. Explorations provided foundation parameters needed to establish a valid technical basis for selecting repair or replacement alternatives for the structure. The preliminary foundation evaluation for the study consists of borings at the west end, and at intervals along the structure and physical analysis of selected borehole samples. Borehole data and sample analysis provides basic engineering criteria for final selection of a repair alternative. The sediments in this shoal are sandy, which meets CWA exclusionary criteria, so Tier II chemical testing is not required for such materials.

Project Description The breakwater is a timber structure composed of 14-inch diameter treated wood piles at 5 feet on center and supporting a double waled, sheathed wall, 2,650 feet in length. The piles are friction type and vary in length of embedment from 20 to 40 feet. Sheathing is 3 X 10 X 16 to 20 foot-long treated wood with 6 to 8 feet of embedment through rock rubble and sand at the base of the wall. The rock is roughly 5 feet thick with 1v on 3h sideslopes, and jet probing indicates it extends about 5 feet from the wall on either side. It is sanded in to some degree, leaving about 2 feet exposed above the current ground line. In addition, assuming the rock was placed as designed, it appears there has also been settlement of the rock fill at the extreme east end of the wall where jet probing failed to confirm the above configuration. However, there was no evidence the wall itself has undergone settlement or misalignment from foundation failure or settlement.

Explorations Explorations were conducted by L. R. Squire & Associates with assistance from the Corps. Sampling was accomplished using a truck-mounted rotary drilling apparatus. Samples for sediment quality analysis were obtained with a split spoon that retrieves a 3-inch nominal diameter core. Engineering samples were obtained using a standard penetration sampler taking a 2-inch nominal diameter core. Penetration resistance was also tested *in situ* with a 1-inch jet probe. The jet probe was used to determine the configuration of the rock rubble fill at the base of the wall. Location of borings is shown on Figure 1.

Summary of Boring Results Four borings were made, two on each side of the wall, and 16 jet probes were made, also along either side of the wall. Penetration testing and sampling revealed the shoal to be composed of poorly sorted, medium sand with varying amounts of shell fragments and organic debris from the top of the hole to a depth of approximately 25 feet. Silt was encountered in all four boreholes at various depths and in varying amounts. Borings DH-96-1 and -2 encountered clay and silt at approximately 27 feet. These borings were stopped in the clay zone at about 32 feet after taking undisturbed samples for shear tests. Split spoon samples were taken at the top of all four borings, but only clean sand was recovered which meets the CWA exclusionary criteria, therefore Tier II chemical testing was not performed on any of the samples.

Summary of Testing Results of physical testing is shown on Table 1. The Physical tests included mechanical analysis on select composited samples from DH-96-1 through -4. In addition, triaxial shear tests were run on Shelby tube samples from DH-96-2. The material from the upper 25 feet of the holes was all poorly-graded sand, which in terms of the entire shoal around the breakwater, is all the same material. Below about 27 feet, the material from about breakwater Sta. 18+00 to 26+00 and beyond, is low strength clay with silt (CH, CL with zones of ML). There is a transition layer with an apparently irregular surface between the sand and clay which was not found in DH-96-2, but appeared to be about 2 feet thick in DH-96-1. The triaxial shear test shows the clays to have a "c" value of 3.79 psi (effective c = 0.31 psi) and Phi value of ~11 degrees (effective Phi = 33.2 degrees).

Discussion The objective of the physical analysis was to determine the suitability of the shoal material as foundation for a shot rock rubble mound breakwater as a replacement alternative for the existing timber pile wall. A secondary objective was to establish the nature of the materials in the shoal that may require excavation during construction operations on the wall. Triaxial test results indicate that due to the presence of the low strength clay layer beneath the sand, the foundation will not support placement of structures exerting higher loads than the existing sands in the shoal. The lateral and vertical extent of the soft clay was not determined except by inference from pile driving data gathered during the marina construction at the Embarcadero and the Port of Newport which both lie to the north across the boat basin from the breakwater. Here the pile driving data suggests a lenticular form to the clay unit, thinning to the west and along the north margin of the marina and thickening to the east and south beyond the marina and upstream end of the breakwater. The sand surface, including the shoal, masks this configuration, while pile driving and drilling indicate the clay slopes downward to the east and directly overlies bedrock on the west. Pile placement indicates at its thickest known part in the marina's upstream reach, the clay is about 30 feet thick and appears to directly overlie bedrock of unknown description. The bedrock was encountered beneath the clay and defines the surface of refusal for the steel piles driven in the marina. Refusal depth and therefore clay thickness, decreases both shoreward and westward relative to the marina and docks. Based on this information it is postulated the clays are confined between the overlying sand and a bedrock surface and either pinch out or are also capped by sand to the east. Assuming either situation, it can be further suggested that a surcharge load applied on the eastern portion of the shoal would be transferred to the low strength clays and cause them to react isostatically. This reaction could

overcome the confining pressure exerted by the overlying sand and rupture the confining layer. In such events the imposed load will sink, displacing the soft material as it is forced from the zone of increased pressure beneath the load. In an extreme case the clay could fail to ever support the load imposed by the breakwater. It is believed that this logic was used in the original design and led to the selection of a sheetpile wall rather than a gravity structure for the breakwater. The stone at the base of the breakwater imposes a minimum load on the foundation and appears to function as toe protection for the sheetpile which would otherwise be subject to scour losses in much the same way as a bridge pier. Of course some of the rock would be removed temporarily during construction. It is probably not necessary to excavate beyond that necessary to get down to the sand line if a repair alternative is selected. Support piles to replace the existing 14-inch diameter treated wood piles can be driven within tolerances needed without removing the rock fill irrespective of which repair or replacement alternative or which type of pile material is selected. However, if "Z" sheet piles are selected for use in the structure, assume some removal of existing rock rubble and sand will certainly be necessary to gain access to the sand foundation to allow unimpeded driving of the sheets. Wood sheet piles can be driven by chisel-pointing the leading edge and driving abutting the existing sheet. It is also customary to cut existing sheets below the sand line and make a butt splice to the new sheet pile. But, for the sake of foundation integrity and environmental continuity, as much of the existing foundation should be left intact as possible.

Conclusions The results of sampling and testing breakwater foundation materials indicate the shoal is composed of an upper layer of poorly graded medium-grained sand overlying bedrock west of the wall alignment change and soft clay east of the alignment change. Due to the exceptionally low bearing values derived from the results of triaxial shear tests on the clay layer, a gravity type structure is not feasible for the North Marina Breakwater site. Further it can be assumed from performance records of the existing breakwater that in-kind repair or replacement alternatives are the most appropriate designs for this site and should be pursued in order to avoid any problems stemming from increasing the loads imposed on the foundation, particularly in the area upstation (east) from about breakwater Station 15 + 00 where the wall alignment changes. Breakwater repairs, including pile driving, could be effected without resort to major excavation of the wall foundation or protective rock rubble at the base of the wall. Further, such major excavation should be avoided under any alternative in order to preserve the integrity of the biotic communities that occupy the shoal and rock rubble mound. However, if a replacement breakwater option is pursued, and major excavation is necessary, the shoal could be excavated using conventional dredging equipment, except for the rock rubble which would limit the type of equipment used to a bucket or clamshell excavator. Based on examination of the samples from the upper 25 +/- feet of the boreholes and surface examination of the shoal during low tide, the materials are all poorly graded medium-grained sand with +/- 1cm of organic silt on the surface (SP with SM-OL). This shoal material meets CWA exclusionary criteria which is suitable for unconfined inwater disposal.